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ASSESSING DEVELOPMENT ALTERNATIVES ON THE M7 EXPRESSWAY

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Abstract

The M7 Expressway is a constituting part of the Vth European Transport Corridor in Hungary and for its 64 km long Balatonfenyves – Becsehely section (including Nagykanizsa bypass) different development options were proposed for economic evaluation. The Balatonfenyves – Becsehely section of the existing main road No 7. has been built on a good alignment and its actual traffic volume is relatively low, so together with the option to build a new expressway (on a new track), other, less ambitious development options were also studied and assessed. For the economic evaluation the traditional cost–benefit analysis methodology was used (British COBA10), completed with sensitivity tests. The economic evaluation of the options led to the conclusion, that only the options containing a modest or ambitious reconstruction/upgrading of the existing road are economically efficient under the current assumptions.

Keywords: transport corridor, development options, economic evaluation, cost–benefit analysis, sensitivity analysis.

1. Introduction

To face challenges raised by the expected accession to the European Union, Hungary is engaged to develop the sections of the European Transportation Corridors in its territory. Huge road investments are planned to develop the highway network. The M7 expressway is a constituting part of the Vth Corridor and for its Balatonfenyves – Becsehely section (including the Nagykanizsa bypass) different development options were proposed. The 64 km long section studied begins at Balatonfenyves (on the SW side of Lake Balaton, chainage 158 km); and ends at Becsehely (near to Letenye and the Hungarian/Croatian border crossing, chainage 222 km).

2. Road Traffic and Traffic Growth in the Vth European Transport Corridor

As a part of the Vth Corridor (Barcelona – Trieste – Ljubljana – Budapest – Barabás – Kiev) and an important element of the national road network, linking the capital city Budapest to the main recreational area of the Lake Balaton and to several recently urbanised areas around Nagykanizsa, Kaposvár, Siófok and Székesfehérvár the M7 road plays an important role in the country's economy. The traffic volumes observed on the roads of the Vth Corridor constitute the base of the economic evaluation of any investment, since the increase of the demand represented by the traffic growth will justify their eventual and timely implementation. *Fig.1* shows the dynamic growth of traffic volumes observed recently on the Slovenska Bistrica – Budapest section. These data reflect that on the Balatonfenyves–Becsehely section of Highway No 7, the traffic volume is fairly low: AADT $= 4000 - 7000$ vehicles/day and remains far below the theoretical capacity limits.

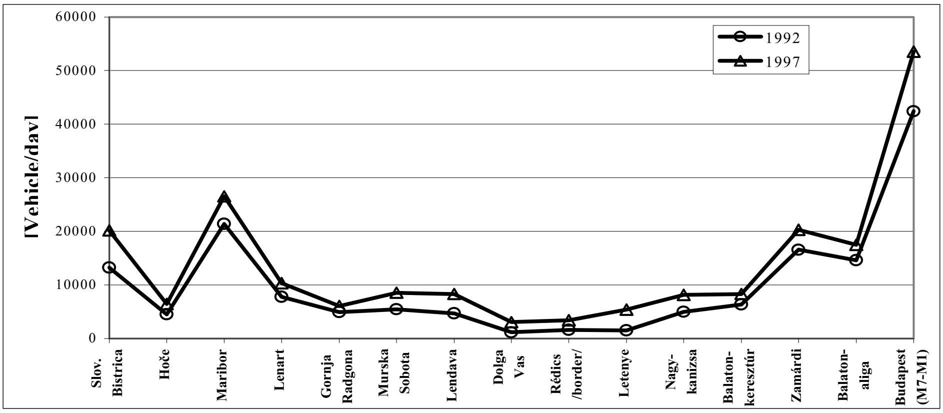

Fig. 1. Traffic volumes in the Vth Corridor on the Slovenska Bistrica – Budapest section from 1992 to 1997

3. Development Options of the M7 Expressway on the Balatonfenyves – Becsehely Section

According to the Long term Development Plan of the Hungarian Expressway Network approved by the government in 1999 (Decree No. 2117/1999), the M7 expressway from Zamárdi to the State border is expected to be developed in stages. The expressway or first carriageway has to be built with appropriate parameters, allowing further develoments into a full motorway.

Under the prevailing budgetary and financing constraints, different development options were proposed and assessed for the section Balatonfenyves – Becsehely.[1]

These are the following:

[1] The present alignment is quite modern. It was constructed around 1952, partly for potential military purposes.

Table 1. Average Time Value per person and per vehicle (Hungarian parameters) [Source: COBA and KTI (1994)]

Vehicle Type	Occupancy	Type of Usage	Value of Time [HUF/hour] (EUR/hour)	
			per Person	per Vehicle
Passenger Car	1.00 driver 0.65 passenger	14.6% of the total output [veh.km] is on business purpose	1056 (4.15) 490 (1.92)	590 (2.32)
Light Truck	1.00 driver 0.74 passenger	72% of the total output [veh.km] is on business purpose	1056 (4.15) 490 (1.92)	897 (3.52)
Heavy Truck	1.00 driver	on business	1056 (4.15)	1056 (4.15)
Bus	1.00 driver 12.1 passenger 0.10 passenger	on business free time on business	1056 (4.15) 490 (1.92) 1056 (4.15)	7091 (27.9)

'*Option A*' is a '*modest reconstruction*' which includes the widening of the traffic lanes and pavement reconstruction, reducing the number of intersections at grade;

'*Option B*' is an '*ambitious reconstruction*' or upgrading, which includes widening of traffic lanes and converting at-grade intersections to grade separated interchanges;

'*Option C*' is the *construction of a single* 2×1 *lane expressway* on a new alignment, as a first carriageway of a motorway.

4. Economic Evaluation of the Options

For the economic evaluation of the 3 options, a traditional cost-benefit analysis was used applying the British '*COBA10*' methodology and software.

The basic set of assumptions in the COBA method is the following:

1. The expenditures of the operations (construction and development costs and maintenance expenditures) are compared to the expected socio-economic benefits (travel time savings, vehicle operating and accident cost savings) using 'do nothing' and 'do something' cases.
2. The traffic model is built upon a fixed trip matrix appraisal methodology[2], i.e. it operates on the assumption that when an existing road is improved or a new road is built, only traffic flows' reassignment[3] takes place.

[2]Methodology is described by ADLER (1987) and by the COBA Manual (1996).

[3]This means that traffic travelling from an origin to a destination may transfer to the new or improved route but still uses the same origin and destination.

3. Given the traffic assignments before and after the new road is built, the effects of daily and seasonal traffic flow variations on total road user costs can be estimated. Using traffic and economic growth forecast these calculations could be repeated for each of the future 30 years.
4. The traffic growth is calculated using multipliers converting traffic flows from the base year 2000 to a value appropriate to each year during the period of the appraisal.
5. Vehicle operating costs comprise fuel, oil, tyres, maintenance, and depreciation cost components. Vehicle operating cost savings can be calculated from the forecasted traffic flow on the future network using these formula:

$$C_1 = (a + b/v + c * v^2),$$

where:	C_1:	fuel cost
	v:	average speed
	a, b, c:	parameters
	C_2:	$a^1 + b^1/v$
where	C_2:	non-fuel cost
	v:	average speed
	a^1, b^1:	parameters

6. The efficiency indicators calculated are the following:
   a. Net Present Value (NPV), NPV = PVB − PVC [Present Value of Benefits minus Present Value of Costs]
   b. Benefit–Cost Ratio (BCR = PVB/PVC)
   c. Internal Rate of Return (IRR), the discount rate when the NPV = 0

To adjust the evaluation process to the Hungarian circumstances the cost–benefit analysis has been executed twice: first using default English cost parameters (costs in 1994 prices), then actual Hungarian cost parameters (costs in 2000 prices: 1 EUR=254.47 HUF as on 1st of January 2000).

The Hungarian cost parameters can be found in *Tables* 1, 2 and 3. *Table* 4 contains the results of the economic evaluation.

Table 2. Average Vehicle Operating Cost for vehicle categories (Hungarian parameters) [Source: COBA and KTI (1994)]

Vehicle category	Vehicle Operating Cost parameters [HUF], (EUR/100)		
	Fuel		
	a	b	c
Car	3.50 (1.37)	82.9 (32.5)	0.0001754 (0.0000688)
Light truck	5.47 (2.15)	99.2 (38.9)	0.0002354 (0.0000923)
Heavy truck	9.50 (3.74)	594.2 (233)	0.0015598 (0.0006117)
Bus	18.00 (7.08)	351.9 (138)	0.0012449 (0.0004882)
	Non-fuel		
	a^1	b^1	
Car	19.67 (7.73)	49.2 (19.3)	
Light truck	22.82 (8.97)	157.1 (61.6)	
Heavy truck	51.87 (20.4)	976.7 (383)	
Bus	96.20 (37.8)	1106.7 (434)	

Table 3. Average Cost per Accident (Hungarian parameters) [Source: COBA and KTI (1994)]

Road category	Speed codes	Personal Injury Accidents per million vehicle kms	Casualties per Personal Injury Accidents			Cost per accident in 2000 prices [1000 HUF] (1000 EUR)
			Fatal	Serious	Slight	
‘New’ 2 lane road	48/64	0.822	0.014	0.183	1.074	2520 (9.90)
	80/97/113	0.274	0.049	0.351	1.255	4380 (17.21)
‘Old’ 2 lane road	48/64	0.822	0.014	0.183	1.074	2520 (9.90)
	80/97/113	0.304	0.049	0.351	1.255	4380 (17.21)

Table 4. Cost benefit analysis of the development options of ‘M7’ expressway Balatonfenyves–Becsehely section

	Costs [million HUF] and (*million EUR*)				Benefits [million HUF] and (*million EUR*)					Net Present Value [million HUF] and (million EUR) NPV=PVB–PVC	Benefit/ Cost Ratio	Internal Rate of Return %
	Scheme costs	Maintenance expenditure saving		Present Value of Costs PVC= A–C–D	Time savings		Vehicle operating costs (G)	Accidents (H)	Present Value of Benefits PVB= E+F+G+H			
	Do-something scheme cost (A)	Traffic related (C)	Non traffic related (D)		Link transit (E)	Junction delay (F)						
	Default English cost parameters (costs in 1994 prices, discount rate 6.0 percent, evaluation period 30 years)											
Modest reconstruction	2582 10.15	643 2.53	0 0	1939 7.62	9388 36.9	1165 4.58	−276 −1.08	7278 28.61	17556 69.02	15616 61.39	9.05	52
Ambitious reconstruction	7144 27.8	555 2.18	−29 −0.11	6618 26.02	8216 32.3	3654 14.4	−851 −3.35	11103 43.65	22123 86.97	15505 60.95	3.343	22
New alignment	30914 120.3	468 1.84	−72.8 −0.28	30519 120	8795 35.06	2025 7.96	−1769 −6.95	3177 12.49	12228 49.5	−18291 −74.05	0.4	–
	Actual Hungarian cost parameters (costs in 2000 prices, discount rate 6.0 percent, evaluation period 30 years)											
Modest reconstruction	3663 14.4	911 3.58	0 0	2752 10.82	6117 24.05	761 2.99	−70 −0.28	1950 7.67	8758 34.43	6007 23.61	3.183	18
Ambitious reconstruction	10134 39.43	787 3.1	−41 −0.16	9387 36.9	5351 21.04	2386 9.38	−1184 −4.65	2976 11.7	9523 37.46	142.5 0.56	1.015	6.6
New alignment	43854 172.4	664 2.61	−102 −0.4	43292 170.2	5608 22.05	1322 5.2	−3269 −12.85	945 3.71	4606 18.65	−38686 −156.6	0.106	–

4.1. Estimated Costs

The construction and development costs[4] (see *Table 4*, cost 'A') were calculated without tax, in 2000 year prices. Road maintenance and operation costs[5] (see *Table 4*, cost 'C' and 'D') are divided into traffic related costs (operational costs and maintenance of drainage, guardrails, road markings, verges etc.) and non traffic related costs (resurfacing, surface dressing and patching).

4.2. Estimated Benefits

To achieve better accessibility of Nagykanizsa, its surrounding area and Lake Balaton, travel times have to be substantially reduced. Travel time savings (see *Table4*, cost 'E' and 'F') are the major components of benefit resulting from the proposed road improvements. Besides time saving, accident cost savings (see *Table 4*, cost 'G') and vehicle operating cost savings were also calculated (see *Table4*, cost 'H').

Finally, both Option A and Option B had positive Net Present Values (Option A: 23.61 million EUR, Option B= 0.56 million EUR). Due to high capital costs (construction and development), Option C has negative NPV (-156.6 million EUR) under the applied assumptions.

5. Sensitivity Analysis of the Options Assessed

The calculation of efficiency indicators like the Net Present Value, Benefit Cost Ratio and Internal Rate of Return is always based on assumptions used as inputs for the assessment. Using sensitivity analysis robustness of these results can be tested against any changes of the basic assumptions. In that way changes with substantial consequences on the efficiency indicators can be identified. Sensitivity analysis allows to detect the impact of expected changes of input variables (such as, construction cost overruns, traffic growth of different vehicle categories, interest/discount rate, value of time, value of accidents etc).

To test the robustness of the results applying sensitivity analysis, the impacts of eventual changes in traffic growth (basic assumption: 3%/year) and that of travel time value, vehicle operating and accident costs (*Tables 1–3*) were tested. The following cases were studied:

- Case 1 using the English cost parameters (as in the original cost–benefit analysis)

[4] Investment costs, other relevant details were taken from relevant technical and financial documents [3, 4, 5].

[5] The basic prices for maintenance and operational costs are derived from the study of Institute for Transport Science (1994): The most important basic information and relations for road traffic, Budapest 1994, p. 120.

- Case 2 assuming a traffic growth 10% higher than the base case (3.3%/year) and using the Hungarian cost parameters
- Case 3 assuming a traffic growth 10% lower than base case (2.7%/year) and using Hungarian cost parameters.

All the cases were compared to the base case using the Hungarian cost parameters. The results of the sensitivity analysis of BCR are shown in *Table5*. It is obvious that under Option A the sensitivities of the economic evaluation's results against the changes in assumed yearly traffic growth are higher than that calculated for Option B. These sensitivities are even higher in case of Option C. The sensitivity value varies between 0.9 and 3.3 for Option C. Considering the results of the sensitivity tests, it has to be taken into account, that in certain cases the order of magnitude of English and Hungarian input parameters of the same kind is substantially different. The sensitivities against cost parameters' changes are much weaker than that against traffic growth changes.

Table 5. The sensitivities of BCR against changes of traffic growth and cost parameters related to different options

Options	Description	Benefit–Cost Ratio	ΔI	ΔO	S sensitivity
Using Hungarian cost parameters					
A0 option	Modest reconstruction	3.183	–	–	–
B0 option	Ambitious reconstruction	1.015	–	–	–
C0 option	New alignment	0.106	–	–	–
Using English cost parameters					
A1 option	Modest reconstruction	9.05	$\sim 400 - 700\%$	184%	0.46–0.26
B1 option	Ambitious reconstruction	3.343	$\sim 400 - 700\%$	229%	0.56–0.33
C1 option	New alignment	0.4	$\sim 400 - 700\%$	277%	0.7–0.4
10% higher traffic growth (3.3%/year) using Hungarian cost parameters					
A2 option	Modest reconstruction	3.683	10%	16%	1.6
B2 option	Ambitious reconstruction	1.141	10%	12%	1.2
C2 option	New alignment	0.116	10%	9%	0.9
10% lower traffic growth (2.7%/year), using Hungarian cost parameters					
A3 option	Modest reconstruction	2.729	10%	14%	1.4
B3 option	Ambitious reconstruction	0.895	10%	12%	1.2
C3 option	New alignment	0.071	10%	33%	3.3

The results of the sensitivity analysis justified the correctness of the original assumptions under the prevailing circumstances. By changing basic input parameters like traffic growth and cost parameters, the ranking of the options assessed by the cost–benefit analysis remains unchanged.

As a conclusion, it has been demonstrated that for the given time, only the options with modest and ambitious reconstruction are economically efficient. Thus they return the investment costs during a reasonable assessment period. The construction of a single 2×1 lane expressway on a new alignment assessed as Option C is actually not economical, even when using English parameters. Taking into consideration the results of the sensitivity tests, only a traffic growth rate that is 2–3 times higher than assumed for the base case would lead to a positive NPV or a BCR reaching 1.0, i. e. making Option C economically efficient and justifiable. Nowadays the ambitious reconstruction (Option B) can be considered as an economically reasonable solution to upgrade the existing No. 7 highway and to decrease travel time. Under that option better accident rates can be expected than under Option A (modest reconstruction), i. e. the traffic safety gains are considerable.

Cost benefit analysis is, however, only an element of the project appraisal and investment decision making process. Along with these results environmental impacts should also be taken into consideration. The assessment can be extended to study regional development and international integration aspects as well. It is not unlikely at all, that assessing these criteria together with economic ones, even more ambitious development options will be considered as it is acceptable.

6. Conclusions

The development of M7 expressway will surely contribute to faster and better balanced economical and regional development of Southwest Hungary. It has been demonstrated that an appropriate economic evaluation of the proposed options is a good basis for selecting the best suitable one to achieve the objectives of the national expressway network development plan. As the traffic volume on the Balatonfenyves – Becsehely section of the main road No 7. is relatively low, a thorough study of the results of the cost–benefit analysis and sensitivity tests is recommended for the decision makers. The close co-operation of the decision makers and representatives of the settlements involved is also necessary to select the best affordable development option.

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